LM567/LM567C Tone Decoder

General Description
The LM567 and LM567C are general purpose tone decoders designed to provide a saturated transistor switch to ground when an input signal is present within the passband. The circuit consists of an I and Q detector driven by a voltage controlled oscillator which determines the center frequency of the decoder. External components are used to independently set center frequency, bandwidth and output delay.

Features
- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%
- High rejection of out of band signals and noise
- Immunity to false signals
- Highly stable center frequency
- Center frequency adjustable from 0.01 Hz to 500 kHz

Applications
- Touch tone decoding
- Precision oscillator
- Frequency monitoring and control
- Wide band FSK demodulation
- Ultrasonic controls
- Carrier current remote controls
- Communications paging decoders

Connection Diagrams

Metal Can Package
Order Number LM567H or LM567CH
See NS Package Number H08C

Dual-In-Line and Small Outline Packages
Order Number LM567CM
See NS Package Number M08A
Order Number LM567CN
See NS Package Number N08E
Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage Pin
9V
Power Dissipation (Note 1)
1100 mW
V8
15V
V3
-10V
V3
V4 + 0.5V
Storage Temperature Range
-65°C to +150°C
Operating Temperature Range
LM567H
-55°C to +125°C
LM567CH, LM567CM, LM567CN
0°C to +70°C

Soldering Information
Dual-In-Line Package
Soldering (10 sec.) 260°C
Small Outline Package
Vapor Phase (60 sec.) 215°C
Infrared (15 sec.) 220°C
See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

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Electrical Characteristics

AC Test Circuit, T_A = 25°C, V^+ = 5V

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Power Supply Voltage Range</td>
<td></td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
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<tr>
<td>Power Supply Current Quiescent</td>
<td>R_L = 20k</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>mA</td>
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<tr>
<td>Power Supply Current Activated</td>
<td>R_L = 20k</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>15</td>
<td>mA</td>
<td></td>
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<tr>
<td>Input Resistance</td>
<td></td>
<td>18</td>
<td>20</td>
<td>15</td>
<td>20</td>
<td>kΩ</td>
<td></td>
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<tr>
<td>Smallest Detectable Input Voltage</td>
<td>I_L = 100 mA, f_o = 20</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>25</td>
<td>mVrms</td>
<td></td>
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<tr>
<td>Largest No Output Input Voltage</td>
<td>I_C = 100 mA, f_o = 10</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
<td>mVrms</td>
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<td>Largest Simultaneous Outband Signal to Inband Signal Ratio</td>
<td></td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td>dB</td>
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<tr>
<td>Minimum Input Signal to Wideband Noise Ratio</td>
<td>B_n = 140 kHz</td>
<td>-6</td>
<td>-6</td>
<td></td>
<td></td>
<td>dB</td>
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<tr>
<td>Largest Detection Bandwidth</td>
<td></td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>10</td>
<td>14</td>
<td>18 % of f_o</td>
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<tr>
<td>Largest Detection Bandwidth Skew</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3 % of f_o</td>
<td></td>
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<tr>
<td>Largest Detection Bandwidth Variation with Temperature</td>
<td></td>
<td>±0.1</td>
<td>±0.1</td>
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<td></td>
<td>%/°C</td>
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<td>Largest Detection Bandwidth Variation with Supply Voltage</td>
<td>4.75 – 6.75V</td>
<td>±1</td>
<td>±2</td>
<td>±1</td>
<td>±5</td>
<td>%V</td>
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<td>Highest Center Frequency</td>
<td></td>
<td>100</td>
<td>500</td>
<td>100</td>
<td>500</td>
<td>kHz</td>
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<td>Center Frequency Stability (4.75–5.75V)</td>
<td>0 &lt; T_A &lt; 70°C</td>
<td>35 ± 60</td>
<td>35 ± 140</td>
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<td>ppm/°C</td>
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<td>Center Frequency Shift with Supply Voltage</td>
<td></td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
<td>0.4</td>
<td>2.0</td>
<td>%/V</td>
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<td>Fastest ON-OFF Cycling Rate</td>
<td>f_o/20</td>
<td></td>
<td></td>
<td></td>
<td>f_o/20</td>
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<td>Output Leakage Current</td>
<td>V8 = 15V</td>
<td>0.01</td>
<td>25</td>
<td></td>
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<td>μA</td>
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<td>Output Saturation Voltage</td>
<td>e_I = 25 mV, I8 = 30 mA</td>
<td>0.2</td>
<td>0.4</td>
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<td></td>
<td>V</td>
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<tr>
<td></td>
<td>e_I = 25 mV, I8 = 100 mA</td>
<td>0.6</td>
<td>1.0</td>
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<td>Output Fall Time</td>
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<td>30</td>
<td>30</td>
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<td>Output Rise Time</td>
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<td>150</td>
<td>150</td>
<td></td>
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Note 1: The maximum junction temperature of the LM567 and LM567C is 150°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient or 45°C/W, junction to case. For the DIP the device must be derated based on a thermal resistance of 110°C/W, junction to ambient. For the Small Outline package, the device must be derated based on a thermal resistance of 160°C/W, junction to ambient.

Note 2: Refer to RET5567X drawing for specifications of military LM567H version.
Typical Performance Characteristics

- **Typical Frequency Drift**
  - Variation with Temperature

- **Typical Bandwidth Variation**
  - Bandwidth as a Function of Frequency

- **Typical Frequency Drift**
  - Variation with Supply Voltage

- **Bandwidth vs Input Signal Amplitude**
  - Detection Bandwidth as a Function of Frequency

- **Largest Detection Bandwidth**
  - Relationship with Center Frequency

- **Detection Bandwidth as a Function of C2 and C3**
  - Graph showing bandwidth variation

- **Typical Supply Current vs Supply Voltage**
  - Supply current limit at various voltages

- **Greatest Number of Cycles Before Output**
  - Bandwidth limited by external resistor

- **Typical Output Voltage vs Temperature**
  - Output voltage variation with temperature

*TLH/6975-4*
**Typical Applications**

### Touch-Tone Decoder

Component values (typ)
- R1: 6.8 to 15k
- R2: 4.7k
- R3: 20k
- C1: 0.10 mfd
- C2: 1.0 mfd 6V
- C3: 2.2 mfd 6V
- C4: 250 mfd 6V

INPUT: 100–220 mVrms
Typical Applications (Continued)

Oscillator with Quadrature Output

Connect Pin 3 to 2.8V to Invert Output

Oscillator with Double Frequency Output

Precision Oscillator Drive 100 mA Loads

AC Test Circuit

Applications Information

The center frequency of the tone decoder is equal to the free running frequency of the VCO. This is given by

\[ f_0 = \frac{1}{1.1 R_1 C_1} \]

The bandwidth of the filter may be found from the approximation

\[ BW = \frac{V_i}{1070} \sqrt{\frac{V_i}{f_0 C_2}} \text{ in } \% \text{ of } f_0 \]

Where:

- \( V_i \) = Input voltage (volts rms), \( V_i \leq 200 \text{ mV} \)
- \( C_2 \) = Capacitance at Pin 2 (\( \mu \text{F} \))
Physical Dimensions inches (millimeters)

**Metal Can Package (H)**

Order Number LM567H or LM567CH  
NS Package Number H08C

**Small Outline Package (M)**

Order Number LM567CM  
NS Package Number M08A
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